

The presence of *Simrothiella borealis* (Odhner, 1921) (Mollusca, Solenogastres: Simrothiellidae) in waters off the Iberian Peninsula

Presencia de *Simrothiella borealis* (Odhner, 1921) (Mollusca, Solenogastres: Simrothiellidae) en aguas de la Península Ibérica

Óscar GARCÍA-ÁLVAREZ*, Luitfried v. SALVINI-PLAWEN** and Victoriano URGORRI*

Recibido el 10-XI-2000. Aceptado el 31-VII-2001

ABSTRACT

This paper offers a description of a species hitherto unknown in Iberian waters, *Simrothiella borealis* (Odhner, 1921), and which has only been cited off the Norwegian coast. The genera of the family Simrothiellidae are discussed and the species of the genus *Simrothiella* are compared.

RESUMEN

En este trabajo se estudia una especie desconocida para las aguas ibéricas, *Simrothiella borealis* (Odhner, 1921), que solamente estaba mencionada en las costas noruegas. Se discuten los géneros de la familia Simrothiellidae y se comparan las especies del género *Simrothiella*.

KEY WORDS: *Simrothiella borealis*, Mollusca, Solenogastres, Galicia, Iberian Peninsula.

PALABRAS CLAVE: *Simrothiella borealis*, Moluscos, Solenogastros, Galicia, Península Ibérica.

INTRODUCTION

Simrothiella borealis (Odhner, 1921) is a species hitherto known only off the Norwegian coasts (ODHNER, 1921), its presence in Galician waters (NW Spain) extends its known distribution considerably. At present, four species of the genus *Simrothiella* Pilsbry, 1898 are known, all of them have a geographical distribution restricted to clearly defined areas and depths between 75 and 5931 m. *Simrothiella margaritacea* (Koren and Danielssen, 1877) has been cited from Norwegian waters (ODHNER, 1921); *Sim-*

rothiella minima (Nierstrasz, 1903) is known from the Gulf of Naples (NIERSTRASZ AND STORK, 1940); and *Simrothiella schizoradulata* Salvini-Plawen, 1978 and *Simrothiella (?) rhynchota* Salvini-Plawen, 1978 have been located in Antarctic and Subantarctic zones (SALVINI-PLAWEN, 1978). The family Simrothiellidae Salvini-Plawen, 1978, characterised by: hollow or solid acicular spicules; a biserial radula; a partially paired radular sac; type C epithelial ventral foregut glandular organs (GARCÍA-ÁLVAREZ, SALVINI-PLAWEN AND

* Laboratorio de Zooloxía Mariña. Departamento de Bioloxía Animal. Facultade de Bioloxía. Universidade de Santiago de Compostela. 15706 Santiago de Compostela. España. E-mail baoscar@usc.es, bavituco@usc.es

** Institut für Zoologie. Universität Wien. Althanstrasse, 14. A-1090 Wien IX. Austria.

URGORRI, 2001), is at present formed by six genera (Table I) with regard to which there are, as in the cases of *Helicoradome- nia* y *Birasoherpia*, serious doubts about their appropriate classification.

MATERIAL AND METHODS

The specimen studied, of 4.2 mm in length and 1.5 mm in width at the anterior part and 1 mm at the posterior part (sectioned in seriated cuts), comes from the fishing bank A Quiniela, situated to the West of the Galician coast (NW Spain), station M-5 (43° 15' 90" N; 09° 36' 36" W) of the CANGREXO I campaign for the study of the brachyuran decapod *Chaeceon affinis* (A. Milne Edwards and Bouvier, 1894) ("cangrexo real"), carried out in June 1991, on bottoms with ferro-

manganasic nodules, calcareous plates and coal slag stones of terrigenous origin, at a depth of 835 m. The specimen was fixed and preserved in 70% alcohol. The spicules were studied by separation of small pieces of cuticle from the central dorsal area of the body and from the ventral groove. These pieces were treated with 5% sodium hypochlorite for 12 hours in order to isolate the spicules; they were then rinsed with distilled water, dried under a heater at 40°C and mounted using synthetic resin. For the anatomical study, the specimen were decalcified in an ethylenediaminetetracetic acid (EDTA) solution 12 hours, embedded in paraffin and a series of 10 µm cross sections cut. which were stained with Azan of Heidenhain. The anatomy was reconstructed from the serial sections.

RESULTS

Order CAVIBELONIA Salvini-Plawen, 1978
Family SIMROTHIELLIDAE Salvini-Plawen, 1978
Genus *Simrothiella* Pilsbry, 1898
Simrothiella borealis (Odhner, 1921)

Description of the specimen studied. *Habitus:* This animal has a thick body, which is somewhat flat dorso-ventrally, no lumps and no keel (Fig. 1A). The spicules project radially from the cuticle, those located right at the back are longer and project backwards. It has a clearly visible pedal groove. In alcohol, its colour is yellowish white.

Mantle: The cuticle is up to 40 µm thick, below it is the epidermis with papillae. The spicules are arrayed in several layers within the cuticle and many of them project radially from it. The spicules are hollow and acicular in form (Fig. 1B), some of them are curved and up to 390 µm in length and others are slightly sigmoidal and up to 230 µm in length. On the pedal groove there are blade shaped scales of up to 100 µm in length (Fig. 1C).

Pedal groove: The pedal groove begins in a ciliated pedal pit situated

below the pharynx (Fig. 2A), which is connected to the outside by a narrow opening. The pedal groove has a ciliated fold, which begins in the pit and enters the pallial cavity.

Pallial cavity: The pallial cavity (Fig. 3A) is connected to the outside by a narrow ventro-terminal opening. It has 10-12 longitudinal respiratory folds, which are long, thin and radially arrayed (Figs. 3A, C). It possesses a couple of strong copulatory spicules, which are situated ventro-laterally to the spawning duct. At the distal end, each copulatory spicule has two smaller lateral spicules, which very closely follow the path of the central copulatory spicule. Besides, each copulatory spicule is accompanied by a voluminous mid-dorsal diverticle, which emerges from the front of the pallial cavity (Figs. 3A, B). The spawning duct open unpaired in the centre of the frontal wall of the

Table I. A comparative table of the generic traits of the genera belonging to the family Simrothiellidae.

Tabla I. Tabla comparativa de las características de los géneros pertenecientes a la familia Simrothiellidae.

	<i>Simrothiella</i>	<i>Cyclomenia</i>	<i>Biserramenia</i>	<i>Birasoherpia</i>	<i>Helicoradomenia</i>	<i>Spiomenia</i>
Cuticle	Thick	Thick	Thin	Thick	Thin	Thick
Spicules	Hollow acicular	Hollow acicular	Hollow acicular Hollow knife-like	Hollow acicular	Massive acicular	Hollow acicular Hollow harpoon-like at the end
Mouth	In the atrium	Not in the atrium	Not in the atrium	In the atrium	In the atrium	In the atrium
Radula	Biserial. Plates with small lateral denticles	Biserial. Plates with small lateral denticles	Biserial. Plates with small lateral denticles	Biserial. Plates with 1 large distal denticle and small lateral denticles	Biserial. Plates a with few large lateral denticles	Biserial. Plates with larges and small lateral denticles
Postbuccal glandular organs	No	No	No	Yes	No	No
Ventral foregut glandular organs	Tipo C Globular	Tipo C Globular	Tipo C Short Globular	No	Tipo C Short tubular	Tipo C Large tubular
Dorsoterminal sense organ	Yes	Yes	No	Yes	Yes	Yes
Copulatory spicules	Yes	Yes	No	Yes	Yes	Yes
Respiratory folds	Yes	Yes	No	Yes	Yes	Yes

pallial cavity, and the anus is located dorsally to the genital pore (Fig. 3A).

Sense organs and nervous system: On its dorsal and lateral walls, the atrium has numerous, long, narrow papillae, which may be individual or form groups of two or four (Fig. 2A). The only atrio-buccal space is connected to the outside ventro-anteriorly via a narrow longitudinal opening. It has just one dorsoterminal sense organ, situated above the middle part of the pallial cavity (Figs. 3A, C). The only part of the nervous system that it was possible to see was a short cerebral ganglion (40-50 μm), situated above the pharynx (Fig. 2A).

Digestive tract: The mouth opens from the posterior area of the atrium (Fig. 2A). It continues in a pharynx which has longitudinal folds on its walls. The back of the pharynx is surrounded by musculature and has

pharyngeal glands (Fig. 2A). The radula is located in a ventral groove of the pharynx, it has strong ventral musculature with massive cells situated longitudinally along both sides of the radular groove (Figs. 2A, B). The radula is biserial and each row is formed by pairs of pectinated plates, of about 50 μm in length with 60 small denticles (Fig. 1D). A short narrow radular sac (30-40 μm in length) is situated ventrally to the oesophagus (Figs. 2A, C). The short ventral foregut glandular organs are epithelial (type C) (SALVINI-PLAWEN, 1978), and opens laterally in the pharynx on both sides of the beginning of the radula (Figs. 2A, B). The structure of these organs is tubular at the front near the opening, whilst at the rear it has a globular aspect which continues below the oesophagus. The pharynx continues into a short oesophagus which opens through a sphincter in the

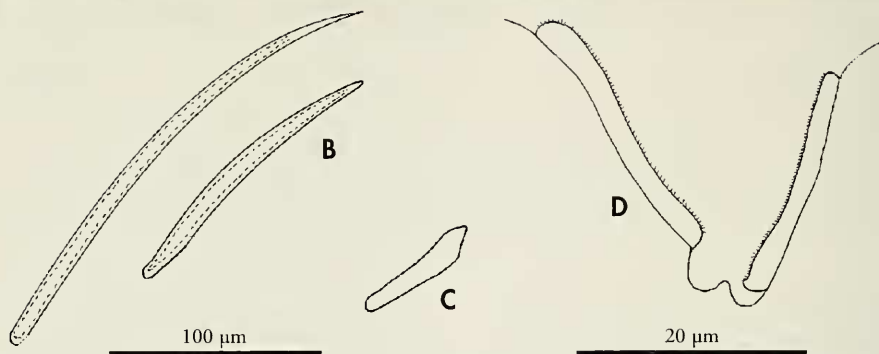
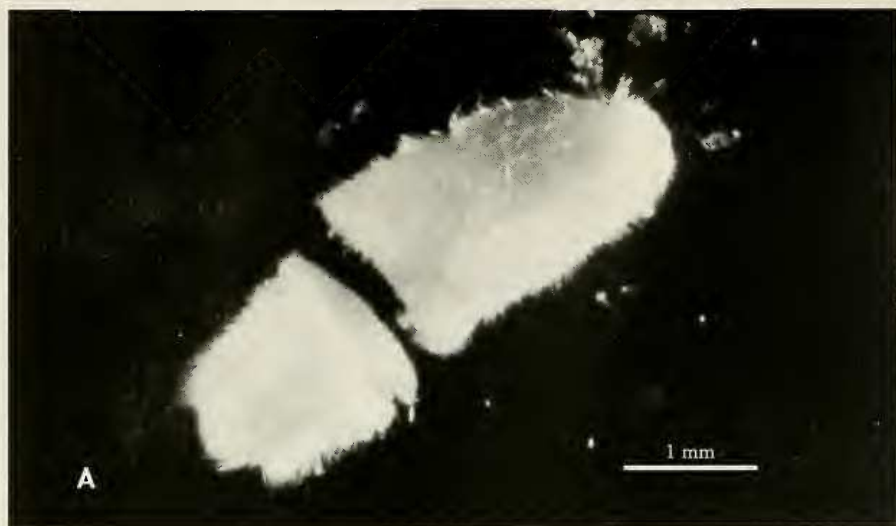


Figure 1. *Simrothiella borealis* (Odhner, 1921). A: habitus; B: acicular spicules; C: spicules along the edges of the pedal groove; D: radula plates.
 Figura 1. *Simrothiella borealis* (Odhner, 1921). A: habitus; B: espículas huecas aciculares; C: escamas de los bordes del surco pedio; D: placas radulares.

centre of the midgut (Figs. 2A, C). The midgut has a short dorso-rostral caecum (Fig. 2A), and has seriated lateral constrictions due to the dorso-ventral musculature. The digestive tract opens into the pallial cavity through the anus, situated dorsally to the genital pore (Fig. 3A).

Reproductive system: The gonads were full of spermatozoa and ovules. The pericardium is voluminous, it contains the heart, which is free and is only linked at the anterior and posterior ends to the

dorsal wall of the pericardium (Fig. 3A). The pericardioducts (Fig. 3A) begin at the back of the pericardium, and curve forwards until they join the anterior part of the spawning duct. The two spawning ducts have a lobular frontal wall, which serves as a seminal vesicle (Fig. 3A). These ducts then join to become a single spawning duct, which open into an unpaired genital pore in the centre of the frontal wall of the pallial cavity. It has two voluminous seminal receptacles, situated laterally to the point where the

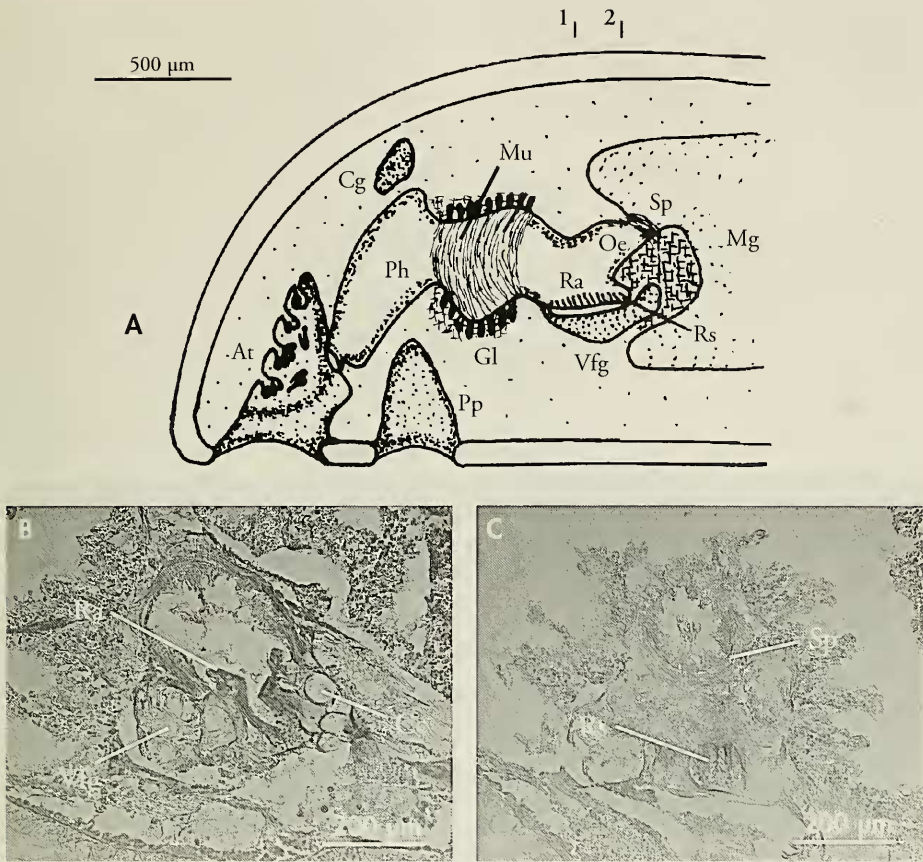


Figure 2. *Simrothiella borealis* (Odhner, 1921). A: schematic organisation of the anterior body; B: cross-section corresponding to line 1; C: cross-section corresponding to line 2.

Abbreviations, At: atrial sense organ; Cc: massive cells; Cg: cerebral ganglion; Gl: pharyngeal glands; Ma: mantle; Mg: midgut; Mu: musculature; Oe: oesophagus Ph: pharynx; Pp: pedal pit; Ra: radula; Rs: radular sac; Sp: sphincter; Vfg: ventral foregut glandular organ.

Figura 2. Simrothiella borealis (Odhner, 1921). A: organización esquemática de la parte anterior del cuerpo; B: corte en sección correspondiente a la línea 1; C: corte en sección correspondiente a la línea 2.

Abreviaturas, At: órgano sensitivo atrial; Cc: células masivas; Cg: ganglio cerebral; Gl: glándulas faríngeas; Ma: manto; Mg: intestino; Mu: musculatura; Oe: esófago; Ph: faringe; Pp: foseta pedia; Ra: rádula; Rs: saco radular; Sp: esfínter; Vfg: órgano glandular ventral de la faringe.

two ducts become one. These receptacles join the single spawning duct dorso-laterally (Figs. 3A, B).

Remarks: *Simrothiella borealis* belongs to the order Cavibelonia, since it possesses several layers of hollow acicular spicules in the cuticle and included within the family Simrothiellidae because of its biserial radula and its type C epithelial ventral foregut glandular or-

gans (SALVINI-PLAWEN, 1978; GARCÍA-ÁLVAREZ *ET AL.*, 2001). The specimen studied has well defined generic characteristics: the buccal opening is in the atrium; the ventral foregut glandular organs are blister-like in shape; the radula is biserial; the midgut has seriated sacs; it has a dorsoterminal sense organ, an unpaired genital orifice, copulatory spicules and respiratory folds (SALVINI-

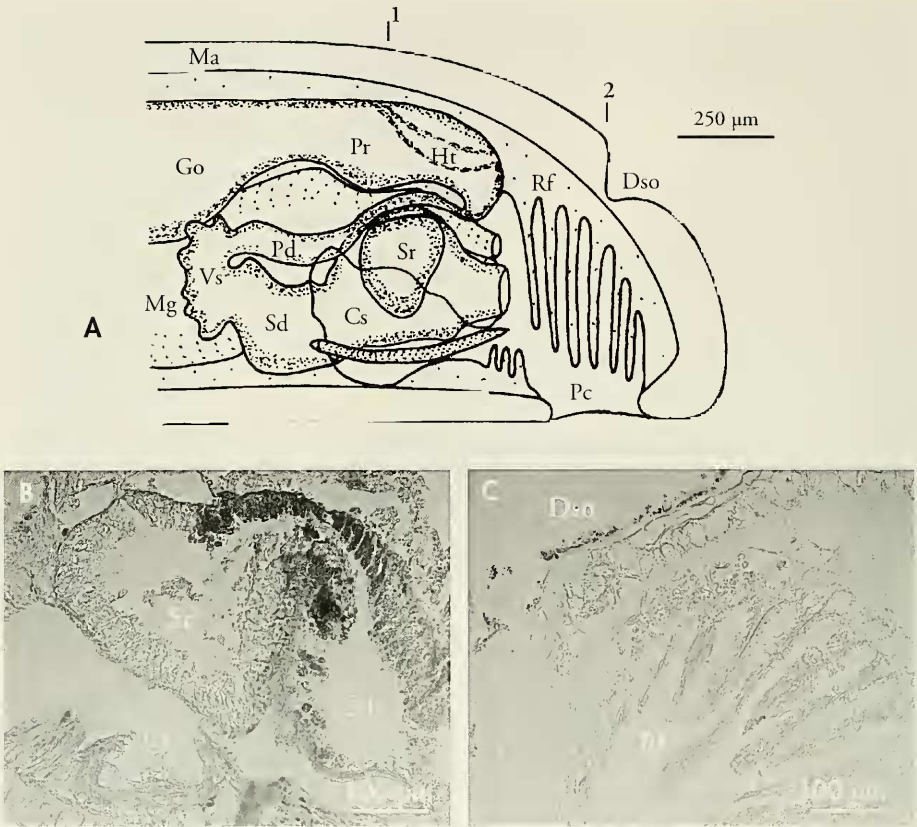


Figure 3. *Simrothiella borealis* (Odhner, 1921). A: schematic organisation of the posterior body; B: cross-section corresponding to line 1; C: cross-section corresponding to line 2.

Abbreviations, Cs: copulatory spicules; Dso: dorsoterminal sense organ; Go: gonad; Ht: heart; ; Ma: mantle; Mg- midgut; Pc: pallial cavity; Pd: pericardioduct; Pr: pericardium; Rf: respiratory folds; Sd: spawning duct; Sr: seminal receptacle; Vs: seminal vesicle

Figura 3.- *Simrothiella borealis* (Odhner, 1921). A: organización esquemática de la parte posterior del cuerpo; B: corte en sección correspondiente a la línea 1; C: corte en sección correspondiente a la línea 2.

Abreviaturas, Cs: espícula copulatríz; Dso: órgano sensitivo dorsoterminal; Go: gónada; Ht: corazón; Ma: manto; Mg: intestino; Pc: cavidad paleal; Pd: pericardioducto; Pr: pericardio; Rf: pliegues respiratorios; Sd: conducto de desove; Sr: receptáculo seminal; Vs: vesícula seminal.

PLAWEN, 1967; SALVINI-PLAWEN, 1978). The characteristics which identify it as *Simrothiella borealis* are clearly defined: it is a small animal with a body with no lumps and no keel; the pedal groove has a fold which enters the pallial cavity; the biserial radula is formed by pairs of pectinated plates; it has a short narrow radular sac; it has a midgut with a small dorsal caecum and seriated constrictic-

tions; it has a pair of lobular seminal vesicles and two voluminous seminal receptacles located at the bifurcation of the spawning ducts, a pair of copulatory spicules, accompanied at the distal end by smaller spicules and 10-12 respiratory folds (ODHNER, 1921).

The specimen studied was collected off West Galicia (NW Spain) at a depth of 835 m. Until now *Simrothiella borealis*

was only known from the coast of Norway (Sunde, Hardangerfjord, Bukennfjord) at depths between 110 and 350 m (ODHNER, 1921). Therefore this

DISCUSSION

The composition of the family Simrothiellidae has recently been modified, since two of the genera belonging to it, *Uncimenia* Nierstrasz, 1903 and *Sialoherpia* Salvini-Plawen, 1978 characterized by having circumpharyngeal glands, have been included, together with the new genus *Unciherpia*, in the family Pararrhopalidae, within the subfamily Unciherpiinae (GARCÍA-ÁLVAREZ ET AL., 2001). For this reason the family Simrothiellidae is at present composed by six genera: *Simrothiella* Pilsbry, 1898, of which 5 species have been described; *Cyclomenia* Nierstrasz, 1902, monotypical; *Biserramenia* Salvini-Plawen, 1967, monotypical; *Birasoherpia* Salvini-Plawen, 1978, monotypical; *Helicoradomenia* Scheltema and Kuzirian, 1991, of which 3 species have been described; and *Spiomenia* Arnofsky, 2000, monotypical (NIERSTRASZ, 1902; SALVINI-PLAWEN, 1968, 1978; SCHELTEMA AND KUZIRIAN, 1991; ARNOFSKY, 2000; SCHELTEMA, 2000). Some of these genera have significant morphological differences (see Table I), and for this reason their origin does not appear to be monophyletic. The genera *Simrothiella*, *Biserramenia*, *Cyclomenia* and *Spiomenia* possess all the synapomorphic characters which define the family, such as: a biserial radula formed by pairs of plates which have small denticles, type C epithelial ventral foregut glandular organs and hollow spicules on the mantle. However, in both *Birasoherpia* and *Helicoradomenia* there are notable morphological differences, which cast doubt on whether they are classified correctly as belonging to the family Simrothiellidae. In the genus *Birasoherpia* there are no ventral foregut glandular organs, but it does possess three ventral postbuccal organs which do not exist in the other genera of the family Simrothiellidae and

record, besides being the first for the coasts of the Iberian Peninsula, considerably extends the geographical and the bathymetric distribution of this species.

whose phylogenetic interpretation is not clear. On the one hand, due the similar position they occupy (SALVINI-PLAWEN, 1978), they are reminiscent of the circumpharyngeal follicular glands, which justify the inclusion of the genera *Uncimenia* and *Sialoherpia* together with *Unciherpia* in the subfamily Unciherpiinae (part of the family Pararrhopaliidae) after considering these a synapomorphic characters (GARCÍA-ÁLVAREZ ET AL., 2001). But on the other hand, such postbuccal glandular organs, could be an autapomorphy of the genus *Birasoherpia* within the family Simrothiellidae. The genus *Helicoradomenia* only has sturdy spicules on the mantle and the radula, although it is biserial, it is formed by morphologically different plates, due it has only a few large denticles.

Only four species of the genera *Simrothiella* are currently known, besides *Simrothiella borealis* (NIERSTRASZ, 1905; ODHNER, 1921; NIERSTRASZ AND STORK, 1940; SALVINI-PLAWEN, 1978). *Simrothiella margaritacea* (Koren and Danielssen, 1877) is a species known only in Norwegian waters, it was collected in Stavanger at 75-115 m, Kopervik at 75-95 m and in the N of Norway at 1400 m. It is differentiated from *Simrothiella borealis* because it has some large radular plates, most of them with numerous denticles, and the anterior plates with only a few strong denticles; the radular sac large and paired; the ventral foregut glandular organs tubular, short and arrayed dorsally to the radular sac; the two seminal receptacles in front of the spawning ducts; and it has 20 respiratory folds. *Simrothiella minima* (Nierstrasz, 1903), is only known from the Mediterranean Sea, collected in the Gulf of Naples between 250 and 1100 m. The descriptions and illustrations presented by NIERSTRASZ (1905) and NIERSTRASZ AND

STORK (1940) for *Simrothiella minima*, have certain similarities with the specimen of *Simrothiella borealis* studied by us, but there are also some clear differences. In the drawings of the radular plates of *Simrothiella minima* there are 30 denticles, whilst *Simrothiella borealis* has about 60; the dorsoterminal sense organ in *Simrothiella minima* occupies a terminal position, whilst in *Simrothiella borealis* it is located dorsally in the middle part of the pallial cavity; the seminal receptacle in *Simrothiella minima* is placed in front of the spawning ducts and not dorso-laterally to them as in the case of *Simrothiella borealis*; and the organisation of the diverticles of the copulatory spicules in *Simrothiella minima* includes glandular cells and does not have small spicules for the purpose of substitution. *Simrothiella schizoradulata* Salvini-Plawen, 1978 is an Antarctic and Subantarctic species found at great depths, it was collected in the Strait of Drake, near the South Shetland Islands at 4780 m and in the Atacama Deep (N. of Perú) at depths between 5821 and 5931 m. It may be distinguished from *Simrothiella borealis* by

its very small atrium; the absence papillae on the epidermis; its pallial cavity with paired terminal sacs, a suprapallial gland and 8 respiratory folds; a pair of very characteristic ventral radular sacs; its midgut does not have a dorsal caecum and it has a pair of seminal receptacles in the form of a sac placed in front of the spawning ducts. *Simrothiella* (?) *rhynchota* Salvini-Plawen, 1978, is a South Pacific species collected at a depth of 3694 m. Little is known of the organisation of the posterior part of the anatomy of this species. The main differences between this species and *Simrothiella borealis* are the radular plates with 20-25 denticles and the pallial cavity with 4 respiratory folds.

ACKNOWLEDGEMENTS

This paper is part of the research projects: Fauna Ibérica III (PB92-0121); CICETGA (20005B95); and "Acciones Integradas de Cooperación Hispano-Austríaca": HU1995-0002; HU1996-0002; HU1997-0002.

BIBLIOGRAPHY

- ARNOFSKY, P., 2000. *Spiomenia spiculata* gen. et sp. nov. (Aplacophora: Neomeniomorpha) collected from the deep waters of the west European basin. *The Veliger*, 43 (2): 110-117.
- GARCÍA-ÁLVAREZ, O., SALVINI-PLAWEN, L. V. AND URGORRI, V., 2001. *Unciherpia hirsuta* a new genus and species (Mollusca Solenogastres: Paratrhophaliidae) from Galicia, northwest of Spain. *Journal of Molluscan Studies*, 67 (1): 113-119.
- NIERSTRASZ, H., 1902. The Solenogastres of the Siboga-Expedition. *Siboga-Expedition Monographie*, 47: 1-46
- NIERSTRASZ, H. F., 1905. *Kruppomonia minima* und die Radula der Solenogastren. *Zoologischen Jahrbüchern Abteilung für Anatomie und Ontogenie der Thiere*, 21: 665-702.
- NIERSTRASZ, H. F. AND STORK, H. A., 1940. Monographie der Solenogastren des Golfes von Neapel. *Zoologica (Stuttgart)*, 99: 1-92.
- ODHNER, N., 1921. Norwegian Solenogastres. *Bergens Museums Aarbok for 1918-1919 Naturvidenskabelig Raekke*, 3: 1-86.
- SALVINI-PLAWEN, L. V., 1967. Kritische Bemerkungen zum System der Solenogastres (Mollusca, Aculifera). *Zeitschrift für zoologische Systematik und Evolutionsforschung*, 5 (4): 398-444.
- SALVINI-PLAWEN, L. V., 1968. Neue Formen im marinen Mesopsammon: Kamptozoa und Aculifera. *Annalen des Naturhistorischen Museums in Wien*, 72: 231-272.
- SALVINI-PLAWEN, L. V., 1978. Antarktische und subantarktische Solenogastres. Eine Monographie: 1898-1974. *Zoologica (Stuttgart)*, 128: 1-315.
- SHELTEMA, A. H., 2000. Two new hydrothermal vent species, *Helicoradomenia bisquamata* and *Helicoradomenia acredema*, from the Eastern Pacific Ocean (Mollusca, Aplacophora). *Argonauta*, 14 (2): 15-25.
- SHELTEMA, A. H. AND KUZIRIAN, A., 1991. *Helicoradomenia juani* gen. et sp. nov. a Pacific Hydrothermal Vent Aplacophora (Mollusca: Neomeniomorpha). *The Veliger*, 34 (2): 195-203.